ISSN 0097-4463

ANNALS
of CARNEGIE MUSEUM

CARNEGIE MUSEUM OF NATURAL HISTORY

4400 FORBES AVENUE • PITTSBURGH, PENNSYLVANIA 15213

VOLUME 50 14 APRIL 1981 ARTICLE 5

MODELING THE DEVELOPMENT OF SEDENTARY MARITIME ECONOMIES ON THE COAST OF PERU: A PRELIMINARY STATEMENT

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ABSTRACT

The date of 5000 B.P. is crucial to the understanding of the development of complex societies on the Peruvian coast. It is at this time that modern sea level was attained and the present coastline stabilized. The rise of complex societies on the coast is discussed in relation to the above factors.

INTRODUCTION

There have been numerous discussions of the origins of maritime subsistence patterns on the central and north coast of Peru; all of which invoke "land based" environmental factors, to explain the shift from hunting and gathering to a maritime subsistence economy at circa 5000 B.P. Lanning (1963) was the first investigator to recognize that extensive maritime subsistence patterns were established by 5000 B.P. and he proposed that littoral economies developed as a response to decreasing animal and plant resources in the lomas, brought on by increased aridity.

Many authors have addressed the question of post-Pleistocene environmental change in the Peruvian coast, either rejecting (Craig and Psuty, 1968; Parson, 1970; Osborn, 1977) or supporting Holocene climate change (Richardson, 1978*a*). All previous investigators, including myself, were concentrating their explanations of maritime origins from inland when, in reality, the answer lay beneath the continental shelf.

Submitted 16 September 1980.

The following discussion will present a model to explain the origins of intensive maritime economies on the Peruvian coast for it is now clear that highly complex societies arose on the central and north Peruvian coast with a maritime subsistence base by 5000 B.P. (Moseley, 1975). As will be demonstrated, the main causal factor in this development was sea level rise and the submergence of the continental shelf prior to 5000 B.P.

Sea Level

Various authors (Shepard, 1964; Milliman and Emery, 1968; Gill, 1971; Clark and Lingle, 1979; Dillion and Oldale, 1978; Morner, 1971; Clark et al., 1978) have estimated the rise of ocean levels since the last glacial maximum at 15,000 years ago. The estimates range from a rise of 85 m to 135 m, with most authors using the latter figure.

From 15,000 B.P., meltice began to increase the volume of water in the ocean basins and by 7000 B.P. sea level was within 20 m of modern sea level which was attained by 5000 B.P. After 5000 B.P. sea level remained constant (Shepard, 1964) or fluctuated several meters above and below the modern level (Fairbridge, 1976). The post-5000 B.P. sea level fluctuation question is not relevant to this discussion but the vertical rise of circa 135 m of sea level and the subsequent submergence of the continental shelf on the west coast of South America has profound implications for understanding the processes of the development of maritime economies on the coast of Peru (Richardson, 1978*b*).

Simpson (1975*a,b*) has stated that the lowering of sea level would have affected the late Pleistocene weather patterns. In the Indo-Australian area, large expanses of continental shelf were exposed, thus preventing the vernal mixing of waters between the eastern and western Pacific. Thus the Pacific anticyclone did not weaken during the glacial summer, which meant that the eastern anticyclone and southeast trade winds would have remained constant throughout the glacial summer and winter (Simpson, 1975*a*:34). The result would have been that the coast of Peru would have been arid during the last glacial and rain would have fallen continuously throughout the summer and winter in the high Andes. The evidence for Simpson's conclusions comes from the recent work on the Galapagos (Colinvaux, 1972) where there was an increase in aridity at high elevations during the Pleistocene. In addition, there is now evidence that there was an increase in upwelling along the Peruvian coast at the zone of equatorial divergence. Luz (1973, 1977) has demonstrated from core data from the South Pacific that the ocean waters were 5–6 degrees cooler than today, and Gates (1976) has postulated that the ocean surface temperatures were lower at 18,000 B.P. If this model proposed by Simpson is a valid one, the various explanations for increase or decrease in rainfall in the central Andes, due to the shifting of the Intertropical Covergence Zone north or south of the equator (for example, Paskoff, 1977; Fairbridge, 1972; Hastenrath, 1971) have no validity.

It can also be suggested that the El Niño phenomenon did not occur during the Pleistocene, because the low pressure center over Indonesia would have not weakened to allow this warm water current to move across the Pacific and down the coast of Peru. In essence the El Niño countercurrent would then be a post-Pleistocene development. The origins of the El Niño current is being debated by oceanographers at present, but most agree that the El Niño current is not a local west coast South American phenomenon, but is part of the overall weather system of the Pacific. Wrytki, Quinn, and others conclude that the El Niño has its origins in the southeast tradewinds and when these trades are strong, they pile up water against the southeast Asian coast where the water level rises 0.5 m above that of the South American coast. With the shift in weather patterns, the low pressure area over Indonesia and the high pressure area near Easter Island, the trade winds decrease in intensity and the ". . . piled up water sloshes back toward South America" (Cromie, 1980:42; Hartline, 1980; Wyrtki et al., 1976). This warm current can be detected by ocean temperatures and sea levels along the line islands in the Pacific; and when it reaches South America, it moves south along the coast as the El Niño current. It has also been discovered that the warm countercurrent can occur at anytime of the year, but that it only affects the Peruvian coast when it arrives during the winter, for at other times the ocean temperature is already high.

BATHYMETRIC DATA

The key to our understanding of the rise of complex societies on the Peruvian coast, with a maritime economy, are the dates of the submergence of the continental shelf and the establishment of essentially modern coastal configurations. Bathymetric charts for west coast South America are not precise enough yet to compute the rate of submergence of the continental shelf as the post-glacial seas rose as has been accomplished for the California coast, where 400 to 500 m of shelf were lost every hundred years (Bickel, 1978:8). On the Atlantic coast of North America, the rise of sea level has been computed at 160 cm per 100 years and Edwards and Merrill (1977) feel that the inland movement of the sea would have been apparent to the prehistoric inhabitant.

The recently published bathymetric maps of the Peru-Chile continental margin and the trench by the Geological Society of America, provide 100 and 200 m depth measurements on the continental shelf

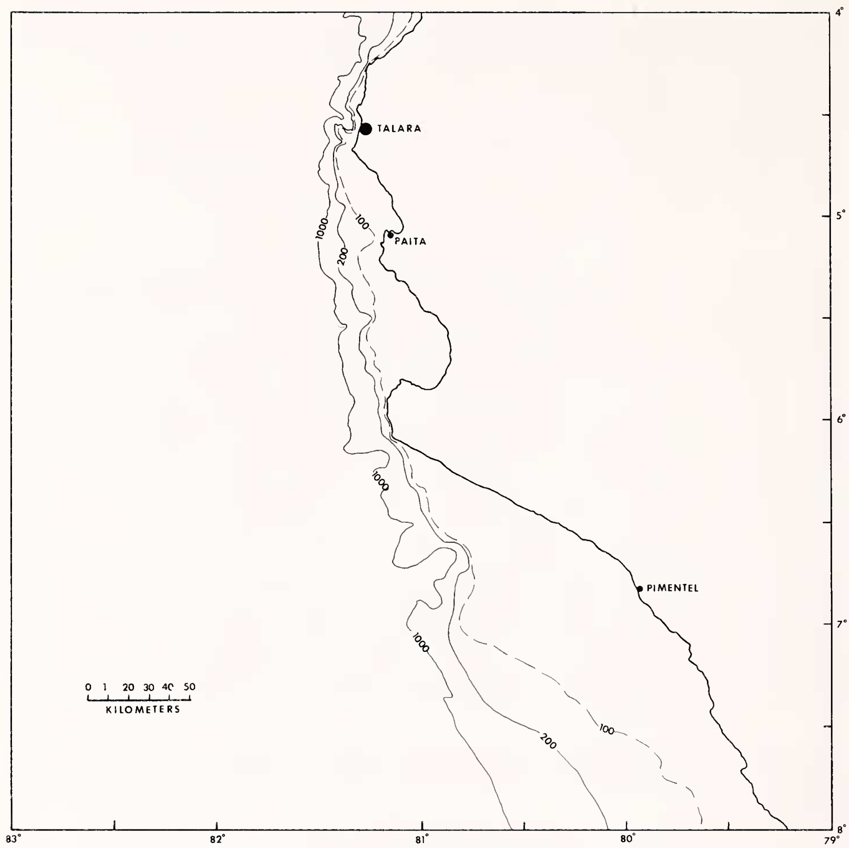

Fig. 1.—Map of the continental shelf and the coast of Peru from 4° to 8° south latitude. Adapted from Prince et al. (1980). Contour intervals in meters.

of western South America (Prince et al., 1980). Maps with less than 100 m depth measurements are restricted to either island groups or shipping ports.

Using the 100 m depth measurement, but keeping in mind that sea level was lowered by 135 m at 15,000 B.P., the expanse of the continental shelf exposed at the 100 m depth interval is over 100 km in some areas. The largest extent of the continental shelf at the 100 m depth is from 6° (Llescus Peninsula) to 12° (Callao) south latitude and it ranges from a width of 20 to 100 km with the widest portion between 6.5° (Pimentel) and 9° (Chimbote) south latitude (Figs. 1–3). For the remainder of the Peruvian south coast the 100 meter depth is at 10–30

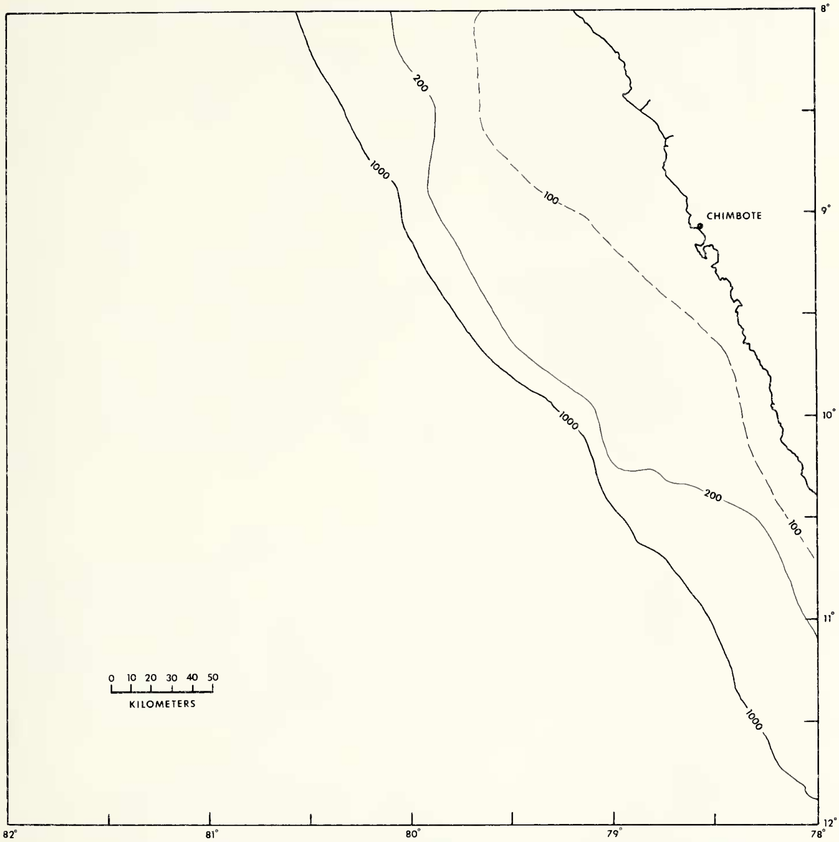

Fig. 2.—Map of the continental shelf and the coast of Peru from 8° to 12° south latitude. Adapted from Prince et al. (1980). Contour intervals in meters.

kilometers, while along the Chilean coast, where the 100 depth is rarely designated, the 200 meter depth is 5 to 10 kilometers from the modern shore, in most cases (Fig. 4).

The best evidence for the date of the establishment of modern coastline along the western South American coast are the beach lines on the Peruvian north coast. The Piura/Chira beach ridges consist of three major sets of raised beaches—the Chira ridges, the Colán ridges, and the Piura ridges. The nine Chira ridges have been dated and the oldest ridge fronting the Pleistocene lobitos marine terrace is dated to 4305 B.P., and the artifact assemblage on this oldest ridge is preceramic

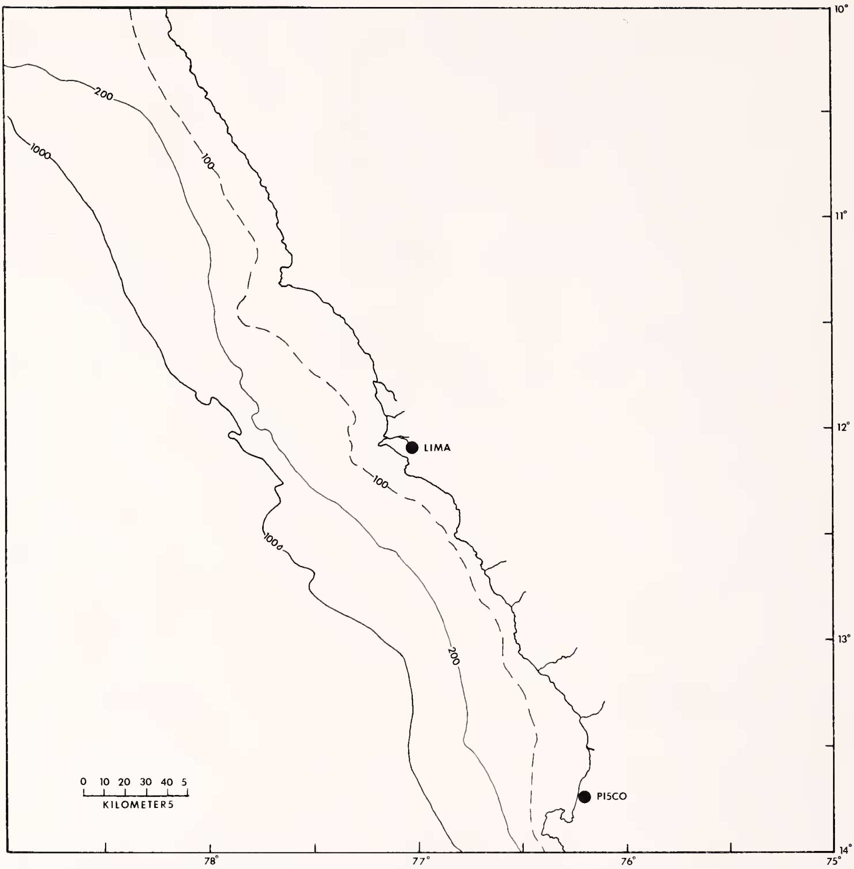

Fig. 3.—Map of the continental shelf and the coast of Peru from 10° to 14° south latitude. Adapted from Prince et al. (1980). Contour intervals in meters.

(Richardson, 1974; Chigne, 1975). The shell caped beach lines were formed by the transport of sediments from the Chira River, which were distributed northward, building up in back of Punta Balcones and Punta Pariñas. The subsequent beach ridges were raised by tectonic uplift and as a consequence a stranded beach system 2.7 km wide resulted.

The point to be stressed here is that the Chira beach ridges began forming only when modern sea level (5000 B.P.) was attained and the present coastline established. Certainly, beach lines were formed prior to 5000 B.P., but these were either submerged as the ocean rose or destroyed by wave action as the sea encroached landward. The Colón ridges are formed of Pleistocene marine pebbles resulting from a geologic structure above the present town of Colán, due to as yet unexplained process. The Piura ridges have a similar sequence to the Chira ridges (McConaughy, personal communication). The only other large set of ridges, are those that emanate out of the Santa River, which have yet to be fully explored. It can be speculated that all Holocene beach ridges on the western South American coast originated *after* modern sea level was reached.

By 5000–5500 B.P., modern shellfish, fish, and sea mammal resources were stabilized and possibly underwent population explosions. Prior to 5000 B.P. these resources were constantly adjusting to the progressive submergence on the continental shelf, but after 5000 B.P. these resources no longer were forced to adapt to increasing depths or changing shorelines as sea level rose, and thus after 5000 B.P., they may well have increased considerably over their previous population levels.

ARCHAEOLOGICAL RECORD

The following four locations on the west coast of South America provide information on the utilization of maritime resources prior to 5000–5500 B.P.—the Vegas complex of the Santa Elena Peninsula, Ecuador; the Amotape/Siches complex of the Talara region of northwest Peru; the Paijan complex of Pampas de Cupisnique on the Peruvian north coast; Quebrada las Conchas site, near Antofagasta, Chile.

The Vegas complex (7000–10,000 B.P.) is best known from the type site (Site 80) near the western end of the Santa Elena Peninsula and from the analysis of the midden deposits, the mangrove mollusk (*Anadara tuberculosa*) represented 24% of the diet, fish 30%, and terrestrial mammals 46% (Stothert, 1977:3; 1980). By 7000 B.P., sea level was within 10 to 20 m below its present level and the continental shelf may have supported a wider zone of mangrove vegetation. The majority of the Vegas middens are situated on the margins of an extensive drainage system at 10 m above current sea level and Site 80, the largest, was located to take advantage of an underground water resource. The question of freshwater support for mangrove vegetation has been thought to have been due to increased rainfall during the Holocene (Sarma, 1974); however, as has been pointed out in the previous section, there is increasing evidence that the Peruvian and Ecuadorian coasts were arid during the late Pleistocene and probably the early Holocene.

Mangroves can survive in hypersaline areas with little or no freshwater for a large part of the year and thus, rainfall may not be a factor

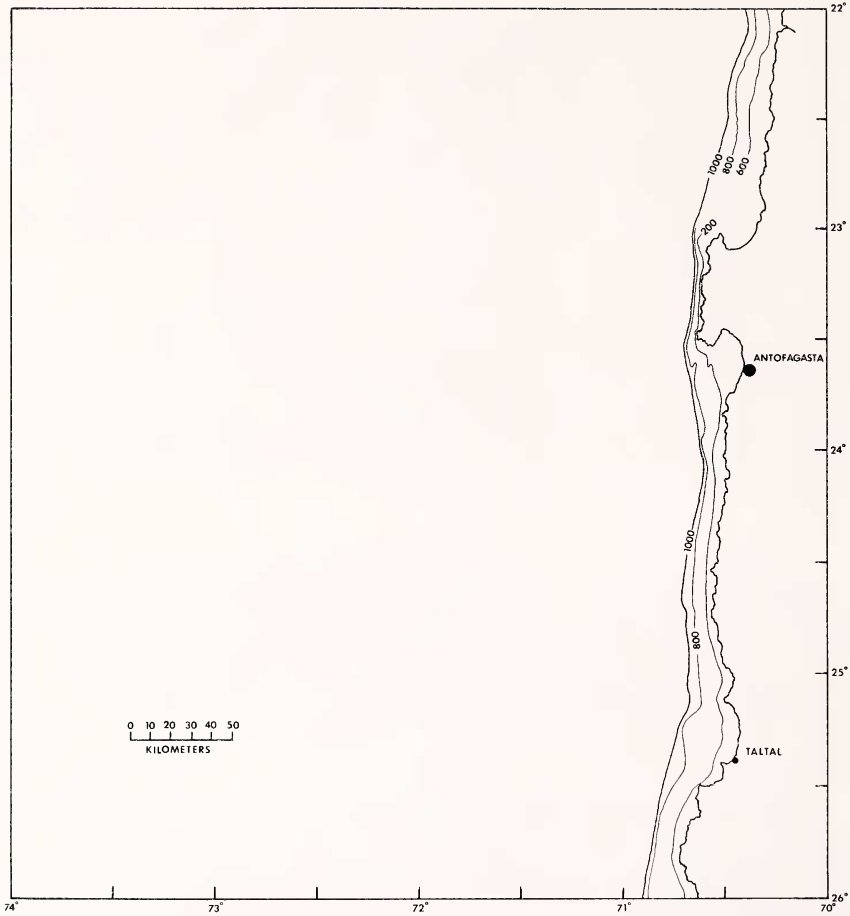

Fig. 4.—Map of the continental shelf and the coast of Peru from 22° to 26° south latitude. Adapted from Prince et al. (1980). Contour intervals in meters.

in the maintenance of mangrove forests. The increase in the meltice runoff may also have been a factor in contributing fresh water for mangrove development on the Eduadorian coast.

In the Talara area, all the Amotape sites are located on the Pleistocene tablazo at 50 m above sea level and 8 km from the present shoreline. These small campsites have scatterings of the mangrove mollusk *Anadara tuberculosa* and two radiocarbon dates place this occupation of the Talara Tar Seep area at 11,200 B.P. and 8125 B.P. For the better known Siches (8–6000 B.P.) period there are numerous sites with middens composed of the mangrove mollusk, all of which are located on the high Pleistocene marine floors overlooking Quebrada Pariñas, Talara Harbor, and the mouth of the Chira River. The largest of the Siches site (PV7-18) is located at the head of the quebrada where fresh water from Tertiary deposits form pools today.

The 100 m sea level depth on the Continental Shelf is at 8 km from the present shoreline at Talara (Fig. 1). With a sea level of minus 20 m the former Holocene Talara shoreline at 7000 B.P. would have been 5 km from the present coast. At 11,000 B.P., the Amotape hunters were using mangrove resources which were approximately 16 km from the beach and the small campsites probably represent small groups of hunters using the Talara Tar Pit zone as part of their seasonal round (Richardson, 1978*a*).

On the Peruvian coast in the Chicama Valley at Quebrada de Cupisnique 15 km from the present coast, Chauchat (1978*a*; 1978*b*; personal communication 1979) excavated two sites with midden accumulations of the Paijan period (PV22-12 and 13). These sites provide the first associated subsistence date with Paijan artifacts, which include marine fish, snails, lizards, desert fox, and the scapula of a deer. It is unclear whether marine shellfish were present, but the analysis has yet to be completed. Site 13 dates at 9810 B.P. and 7740 B.P. Chauchat feels that the Paijan projectile points may have functioned as fish spears. Turnbaugh (1975) has suggested a similar function for broadpoints during the transitional period in the eastern United States. In the Moche Valley, the Paijan sites of La Cumbre and Quirquiac Shelter could have exploited an exposed continental shelf of 100 km wide between 10,000–12,000 B.P. (Ossa and Moseley, 1971). At 12,000 B.P. the 100 m depth level was 100 km from the current coast and it can be postulated that the existing inland Paijan sites, functioned for hunting purposes, while on the former Holocene coast, Paijan populations may certainly have been utilizing or in fact been adapted to a maritime subsistence pattern, whose evidence is now submerged due to the continued rise of sea level.

The only other site with an early date for the use of maritime resources is that of Quebrada las Conchas near Antofogasta, Chile, located 3000 m from the present coastline and dated to 9400 B.P. and 9600 B.P. At this site, extensive shellfish, sea lion, and fish remains were recovered suggesting a reliance upon maritime resources (Llagostera M., 1979; manuscript). The next earliest date for Chilean maritime adaptation is from the Quiani site near Arica with a date 6170 B.P. (Willey, 1971:203). The late Pleistocene shoreline in this area and the modern one were not much different, for the 100 m depth is within 2 km of the present shore.

The exploitation of marine resources is very early on the West Coast of South America, but the evidence for such an early adaptation has only remained in those few areas where the present coastline either approximated or was close to the Holocene coast further out on the continental shelf. The Paijan discovery is very significant for it illustrates that the earliest known populations on the Peruvian coast, included marine resources as part of their overall subsistence pattern. One can postulate that there may be drowned Paijan middens along the north coast 100 km from the present coastline.

The earliest use of maritime resources on the Peruvian coast south of the Sechura Desert, excluding the Paijan example, cannot be dated older than circa 5000 B.P. In the Moche Valley, Alto Salaverry, and Padre Aban reflect a subsistence strategy of the use of rocky headlines and near shore resources, between 4500–3800 B.P., whereas the succeeding Gramalote complex (3800 B.P.) included deep burrowing clams for the first time as well as the large mussel (*Chormytius chorus*) which were mainly adults forms, leading the excavators to speculate that the Gramolote population was exploiting a previously unused resource (Pozorski and Pozorski, 1979*a*; 1979*b*). Thus the total width at 10,000–12,000 B.P. of the area that could have been exploited was enormous as compared to the present desert strip which is a narrow band of 4 to 6 km.

It is only in those areas where the modern coastline is within several kilometers or closer to the former 100 m depth that the evidence for early exploitation of marine resources will be found. If the dates for the Chilean coast are correct, more sites of this time range should exist.

CONCLUSION

The date of 5000 B.P. is critical to our understanding of the rise of complex maritime societies on the coast of Peru for it is at this crucial juncture in Central Andean cultural development that 1) sea level approximates modern levels; 2) modern coastlines are formed; and 3) the modern distribution of modern shellfish, fish, and sea mammal resources were established. The rise of complex maritime societies on the Peruvian central and north coast is then a response to the above set of conditions.

It is now clear, that the earliest populations to inhabit the coast of Peru utilized maritime resources and that much of the evidence for developing maritime economic systems, leading up to 5000 B.P., lies submerged on the continental shelf.

ACKNOWLEDGMENTS

I wish to thank Nathan Hamilton for securing the bathymetric maps and for stimulating discussions concerning maritime adaptations in New England which provided insights incorporated in this paper. Revision of a Paper presented at the Society for American Archaeology Meetings, Philadelphia, 1 May 1980.

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